CATALYTIC GAS SENSOR

BACKGROUND OF THE INVENTION

This invention relates to a catalytic gas detector, and to a method of manufacturing such a detector.

Catalytic gas detectors are used in the continuous monitoring of atmospheres to detect the presence of a low molecular weight flammable gases, such as methane. The principle of operation relies on the fact that small concentrations of hydrocarbon gases are cationically oxidized in air at elevated temperatures over a suitable catalyst such as palladium rhodium, platinum or iridium. The resultant exotherm reaction produces a temperature rise which is sensed by a sensor. There is a direct relationship between the degree of temperature rise and the proportion of combustible gas in the atmosphere being measured.

Sensors of the type described, which are commonly known as pellistors, comprise a coil of a noble metal, such as platinum, covered with a bead of porous catalytic material. The change in temperature referred to above leads to a change in resistance of the coil, which is detected in a Wheatstone bridge-type configuration of which the coil forms a part.

In the case of portable sensing instruments which are reliant on battery power, it is important that the power consumption of the pellistor be as low as possible.

There are two ways of achieving this end:

(i) By increasing the electrical resistance of the wire;

(ii) By decreasing the amount of heat that is lost from the pelestor to its surroundings;

In order to satisfy the first requirement, published UK patent application GB2238617A describes a thin wire in the form of a conductive track deposited on a non-conductive and thermally isolating layer, such as silicon nitride or silicon oxde, which is deposited upon the silicon substrate. Photolithographic processes are commonly used to define the conductive track or heater element. The bead is usually formed by the deposition of a material such as porous alumina on top of the heater element.

In order to satisfy the second requirement, the substrate beneath the isolating layer is generally etched away so that a suspended membrane is formed upon which the heater element is located, thereby increasing the thermal isolation of the heater element, which results in a significant decrease in power consumption. This is important for portable sensing instruments which are reliant on battery power.

SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided a catalytic detector for a flammable gas comprising a substrate and a sensing structure suspended from the substrate,the sensing structure including:

a) a heating element;

b) a temperature sensing element in the form of a layer-deposited electrically conductive track terminating in at least two electrically conductive bridging leads;

c) a catalytic bead associated with the temperature sensing element,

that portion of the substrate which is directly beneath the sensing structure being etched away so as to isolate thermally the sensing structure, and the temperature sensing structure being supported by the bridging leads.

Preferably the leads extend from the conductive track to terminal pads supported on the substrate, the leads having a thickness and cross-sectional profile which allows them to provide complete support for the sensing structure.

Conveniently, the electrically conductive track is sandwiched between a substrate adhesion layer for facilitating adhesion of the conductive track and a superstrate diffusion barrier layer.

Typically the adhesion layer and the diffusion barrier layer are arranged to prevent buckling or twisting of the conductive track when subjected to thermal stress.

The catalytic bead advantageously comprises a catalyst precursor distributed within a refractory carrier.

The refractory carrier typically comprises alumina and the catalyst precursor comprises palladium (II) chloride or palladium (II) nitrate.

Preferably the heating and temperature sensing elements are combined in the form of a single integrated layer-deposited meandering track of platinum.

Typically, the substrate is formed from a planar wafer of single crystal silicon having a base face and a top face, the base face of the wafer being coated with an inert film and the top face being coated with a dielectric film, with the inert film being a silicon dioxide film and the dielectric film being an alumina film.

The leads may have a thickness matching that of the track and a U-orV-shaped cross sectional profile.

The invention extends to a method of manufacturing a catalytic gas detector comprising the steps of:

a) providing a substrate;

b) depositing a heating and temperature sensing element in the form of at least one conductive track onto the substrate;

c) etching away that portion of the substrate directly beneath the conductive track so as to define a cavity over which the conductive track is suspended, with bridging conductors extending between the conductive track and terminals on the substrate; and

d) depositing a catalyst with a refractory carrier onto the conductive track so as to form a sensing structure supported by the bridging conductors.

In a preferred form of the invention, the method includes the step of depositing a dielectric thin film onto the substrate, the film being chosen from a material which serves as a diffusion barrier, as an adhesion layer for facilitating adhesion of the conductive track and having a thermal expansion coefficient which matches that of the conductive track.

The dielectric thin film is typically formed from alumina and the substrate is a silicon wafer.

Conveniently, the method includes the step of annealing the catalytic gas detector in a single step for stabilizing the electrical properties of the platinum, and for facilitating adhesion and cohesion of the catalyst and carrier and conditioning of the catalyst.

According to a still further aspect of the invention there is provided a method of manufacturing a sensing structure for a catalytic gas detector comprising the steps of:

a) depositing a conductive track onto a substrate;

b) preparing a catalyst comprising a noble metal on a refractory carrier by treating the catalyst with a catalyst precursor so as to form a slurry or paste;

c) applying the slurry or paste to the conductive track by screen printing or stenciling; and

d) calcining the slurry or paste in air.

Preferably, the method includes fiber steps of preparing a compensating or reference element by treating or "poisoning" the refractory carriers which may be alumina, with an alkali metal, and preparing the catalyst by wet milking a palladium (II) chloride catalyst precursor with sub-micron alumina powder, with the palladium particles, formed on